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Reports

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Preliminary Investigation of the Relationship Between
Montane Meadow Stubble Height and Small Mammal
Communities on Carson National Forest, New Mexico

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**Preliminary Investigation of the Relationship
Between Montane Meadow Stubble Height
and
Small Mammal Communities on
Carson National Forest, New Mexico**

**A Final Report
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Table of Contents

Executive Summary	3
Background	5
Purpose	5
Methods	
Small Mammals	5
Stubble Height	6
Study Sties	6
Results	
Stubble Height	8
Small Mammals	9
Non-Mammalian Species	9
Discussion	10
Summary and Recommendations	12
Acknowledgments	13
References	13

Executive Summary

Purpose

- The purpose of this study was to obtain preliminary data on the relationship between stubble height in montane meadows with different grazing histories and small mammal communities on Carson National Forest.

Method

- Small mammals were sampled in three similar montane meadows that differed in livestock grazing histories and stubble height.
- Small mammals were sampled with approximately 150 Sherman live-traps set in three transects on one night in each meadow.
- A representative series of specimens was preserved as standard museum voucher specimens to verify identifications and to document the provenance of the data.

Results

- There was a relationship between stubble height and the diversity of small mammals in each meadow. The meadow with the highest stubble height (Ojo Sarco) had four species, the meadow with moderate stubble height (US Hill) had two species, and the meadow with the lowest stubble height (Amole) had one species.
- There was a relationship between stubble height and the abundance of small mammals in each meadow. The meadow with the highest stubble height (Ojo Sarco) had 6.66 mammals captured per 100 trap-nights, the meadow with moderate stubble height (US Hill) had 2.72 mammals captured per 100 trap-nights, and the meadow with the lowest stubble height (Amole) had 1.33 mammals captured per 100 trap-nights.
- Two species of vole were captured at the Ojo Sarco meadow; no voles were captured at the other two meadows.

Discussion

- Due to small sample sizes, results should be considered preliminary and not conclusive.
- The high richness, diversity and abundance of small mammals at the Ojo Sarco meadow was likely due to the influence of tall, dense graminoid vegetation on vole occurrence and abundance.
- Voles generally do not occur in the absence of adequate stubble height.
- Voiles are particularly important to overall ecosystem structure and function, especially as prey to vertebrate predators.

- It is likely that the US Hill and Amole meadows would experience increases in richness, diversity and abundance of small mammals if stubble height were greatly increased.
- A dramatic decrease in stubble height on the Ojo Sarco meadow would likely result in the extirpation of vole populations.

Recommendations:

- Additional studies are needed to establish the generality of the patterns observed in this study.
- Additional studies are needed to determine threshold levels of stubble height required for vole survival, reproduction, and population increase.

Background

Small mammals are important components of terrestrial ecosystems. They can regulate ecosystem structure and function, they can be the dominant component of animal biomass, they contribute to local and regional diversity, and they serve as important prey for most larger-bodied vertebrate predators. Human land-use practices can greatly impact and alter small mammal communities. As a consequence, changes in small mammal communities can impact ecosystem-level processes. These dynamics are especially notable in grassland ecosystems because livestock grazing can greatly alter the species composition and structure of the vegetation. Small mammal communities may be substantially impacted by these changes especially due to 1) the loss of vegetative cover, which is important for thermal regulation and escape from predators, 2) the loss of seed production, which is an important source of food for some species, and 3) the drying of the soil, which can limit free-water for drinking (required by some species), inhibit burrowing, result in changes in vegetation structure and result in declines in food quantity and quality. Consequently, management of grazing systems can have a profound effect on small mammal communities and overall ecosystem structure and function.

Purpose

The purpose of this study was to investigate the relationship between stubble height and small mammal communities in montane meadows on the Carson National Forest, New Mexico. Results can be used to help determine if future research is needed. However, data presented in this report should be considered preliminary and of an investigative nature and should not be used for other purposes.

Methods

Small Mammal Sampling.—Small mammal communities were sampled in three montane meadows on the Camino Real Ranger District of the Carson National Forest from 23-24 July 2003. Sampling was conducted with standard Sherman live traps baited with horse sweet-feed. In each meadow, approximately 150 traps were placed in three transects consisting of 50 traps set 5 m apart. One transect in each meadow was situated within the most conspicuous drainage. The other two transects were situated in such a way as to sample a maximum area of the meadow.

A representative sample of the small mammal community of each meadow was collected as voucher material; the remainder was released. Collected animals were prepared as standard museum specimens consisting of a skin, full skeleton, and tissue samples (heart, liver, kidney). Specimens will be accessioned into an accredited natural history museum in New Mexico. Species

identifications were verified by Dr. Frey through examination of morphologic characteristics.

Stubble Height.—Information on grazing history and data on stubble height were provided by Carson National Forest Sean Kelly and Deanna Williams, personal communication). The following methodology is modified from that described by S. Kelley and emailed to D. Williams on 18 August 2003. Stubble height transects were run within five days of the trapping. The Amole meadow appeared to have the lowest stubble height, and most recent grazing, implying the greatest potential to be biased by regrowth. It was measured one day after the trapping on 25 July 2003. The other two meadows were measured on 29 July 2003. The locations of the small mammal transects were described and shown to the Forest Service personnel conducting the stubble height survey. The stubble height transects started at the same point as the trappers lines and their same general directions were followed. The trap lines were identified by the trappers names, so the stubble height transects were also identified as such. Andrew's trap lines followed the lowest points winding along the bottom of drainages. The other two trappers' lines (Jennifer, Jason) were more or less straight across the meadows. Two paces were taken between sample points, and the stubble height of the nearest plant was measured in inches. The plant was identified and obvious grazing was noted. There were 50 sample points for each transect except for Andrew's trap line in Amole meadow, which had only 48 due to a large bare patch in the bottom of a small headcut. The average stubble height was calculated as well as that for each plant species.

Study Sites

Ojo Sarco Meadow.—The Ojo Sarco meadow was located at "Ojo Sarco Canyon, Ojo Sarco Tank, 4.5 mi. N, 8.5 mi. E Peñasco, T23N, R13E, SW $\frac{1}{4}$ Sec. 7, N 36° 14.264, W 105° 36.194, 2, 494 m (= 8,180 ft.)". This was a relatively small meadow in the lower mixed conifer zone. The surrounding vegetation included ponderosa pine, white fir and large Gamble's oak. Grass in the meadow was extremely dense and tall. An earthen tank in the meadow held water and was surrounded by a dense stand of cattail. The meadow drainage had shallow standing water and dense sedges. A total of 150 traps were used to sample this meadow.

The Ojo Sarco meadow is a rehabilitated meadow comprised of a near monoculture of non-native Smooth Brome. It was not part of any active grazing rotation at the time of the study. Grazing on the Ojo Sarco meadow was limited to one week of unauthorized use by 11 head of cattle for approximately 5 days from 14 July to 19 July 2003. Ocular estimates made on the day of the stubble height survey were less than 10% utilization.

U.S. Hill Meadow.—The U.S. Hill meadow was located at “Junction NM 518 and FS Rd 114, 2.75 mi. N, 5.0 mi. E Peñasco, T23N, R13E, SE $\frac{1}{4}$ Sec. 19, N 36° 12.621, W 105° 35.783, 2,779 m (= 9,115 ft.)”. This was a relatively large meadow in the upper ponderosa pine zone. Herbaceous vegetation in the meadow was generally short and relatively sparse. There was a high proportion of forbs and bare ground. The meadow drainage had more dense grass but it remained relatively short. An earthen tank in the meadow had a muddy bottom but no associated riparian habitat. A total of 147 traps (three transects of 49 traps) were used to sample this meadow.

The U.S. Hill meadow is part of the Telephone pasture of the Rio Pueblo allotment. Grazing on the U.S. Hill meadow ended on 10 June 2003. Paired cage utilization measurements taken in this meadow on 11 June 2003, resulted in preliminary mid growing season estimates of 49%.

Amole Meadow.—The Amole meadow was located at “Amole Canyon, 1.25 mi. N, 2.5 mi. E Peñasco, T23N, R13E, NW $\frac{1}{4}$ Sec. 31, N 36° 11.267, W 105° 36.350, 2,531 m (= 8,302 ft.)”. Herbaceous vegetation in the meadow was very short (< 5 cm), sparse, and consisted of a high proportion of forbs. There was considerable bare ground. The meadow drainage was a simple depression; there was no moist soil or an obvious difference in plant species composition or structure in the depression. A total of 150 traps were used to sample this meadow.

The Amole meadow is part of the Amole pasture of the Rio Pueblo allotment. Grazing on the Amole meadow was scheduled to end on 9 July 2003, although some grazing had been going on up until the trapping night. Paired cage utilization measurements taken in this meadow on 16 July 2003 resulted in preliminary mid growing season estimates of 55%.

Results

Stubble Height.—Stubble height estimates for the three meadows are presented in Table 1. The average stubble height on the Ojo Sarco meadow (15.8 inches) was 3 to over 4 times higher than found in the other two meadows (3.7 inches at Amole and 5.1 inches at U.S. Hill). The Amole meadow had the lowest stubble height.

Table 1. Mean stubble height (in inches) for three transects in each of three montane meadows on Carson National Forest in July 2003.

Species ¹	Amole			U.S. Hill			Ojo Sarco		
	Andrew	Jennifer	Jason	Andrew	Jennifer	Jason	Andrew	Jennifer	Jason
Acmi	3.5	3	1			1.8	1.9		5
Agcr								8	
Agsm	4.5	3.4	4.85			4.6	6.2		7
Agsp									29
ALOP	5.5	1.5	4.25						
Arfr						4.7			
Bogr		1.3	1.7						
Brin	2					2.93	3.1	11	18.2
Cafi	2.2	2.16	2.1	6.3		3	3		16.6
CARE	1.5			5.7				14.1	15.4
G1	2.4								
G2		3.7							
JUNC	5	7	4	9	5.8	7.5	21.5	14.5	14
Koma								17	4
Phpr							13.5	28.6	25.3
Popr	2.6	4.2	2.8	5.8	2.3	5.6	13.8	13.5	8.3
Sihy	7		6.7	9		10			
STIP					9				
Mean	3.6	3.6	3.8	6.2	3.7	5.4	15.1	16.7	15.5

¹Acmi—*Achillea millefolium*, Agcr—*Agropyrum cristatum*, Agsm—*Agropyrum smithii*, Agsp—*Agropyrum spicatum*, ALOP—*Alopecurus sp.*, Arfr—*Artemisia frigida*, Bogr—*Bouteloua gracilis*, Brin—*Bromus inermis*, Cafi—*Carex filifolia*, CARE—*Carex sp.* (probably *Carex aquatilis*), G1—unidentified grass #1 (probably ring muley *Muhlenbergia torreyi*), G2—unidentified grass #2, JUNC—*Juncus sp.*, Koma—*Koleria macrantha*, Phpr—*Phleum pratense*, Popr—*Poa pratensis*, Sihy—*Sitanion hystrix*, STIP—*Stipa sp.*

Small Mammals.—A total of 16 small mammals of three species were captured in a total of 447 trap-nights. This was an overall capture rate of 3.60 %. Capture rates differed among the sites (Table 2). Highest overall relative abundance was found at the Ojo Sarco meadow (6.66 %) while the lowest overall relative abundance was found at the Amole meadow (1.33 %). Species richness and diversity was substantially higher in the Ojo Sarco meadow than in either of the meadows with lower stubble height (i.e., U.S. Hill and Amole; Table 1). The North American deermouse (*Peromyscus maniculatus*) was present at all three sites, but was more abundant at the Ojo Sarco meadow (highest stubble height) and least abundant at the Amole meadow (lowest stubble height). The long-tailed vole (*Microtus longicaudus*) and the meadow vole (*Microtus pennsylvanicus*) were found only in the Ojo Sarco meadow. In addition to trapping results, we observed northern pocket gopher (*Thomomys talpoides*) mounds at both the Ojo Sarco and U.S. Hill meadows; we did not observe gopher mounds in the Amole meadow, which had the lowest stubble height.

Table 2. Species composition (captures per 100 trap-nights), trap success, richness and diversity of small mammals captured in three montane meadows in the Carson National Forest.

	Ojo Sarco	U.S. Hill	Amole
Species Composition			
Northern pocket gopher	present	present	absent
Deer Mouse	3.33	2.72	1.33
Long-tailed vole	1.33	0	0
Meadow vole	2.00	0	0
Trap success	6.66%	2.72%	1.33%
Richness	4	2	1
Simpson Diversity ¹	2.63	1	1

¹Simpson Diversity calculated from the trapping data: $D = 1/\sum p^2$ where p is the fractional abundance of the i th species.

Non-mammalian species.—During this study, a smooth green snake (*Liophidium vernalis*) was observed at the Ojo Sarco meadow. In New Mexico, this species occurs as relict populations in the higher mountains of the northern and eastern part of the state (Degenhardt et al. 1996). They are associated with grassy or herbaceous areas with permanent moisture and, in New Mexico, are especially associated with grassy areas and adjacent rocky areas along watercourses (Degenhardt et al. 1996). Given the lack of cover, it is unlikely that this species occurs at either the U.S. Hill or Amole meadows.

Discussion

The overall capture rate in this study was relatively low. Typical capture rates using similar technique in ponderosa pine and lower mixed conifer forest zone ecosystems in New Mexico are generally 5 – 15 % (personal observation). The low capture rates in this study partially reflected regionally low small mammal population densities due to prolonged drought conditions (see Frey 2003). However, overall trap success was also influenced by extremely low capture rates in both meadows with low stubble height. The higher capture rate in the Ojo Sarco meadow (highest stubble height) was more typical of those expected for a healthy meadow community.

The meadow with the highest stubble height (Ojo Sarco) had the highest abundance, richness, and diversity of small mammals. This was primarily attributable to the occurrence of two species of voles that were not found in the two meadows with low stubble height. In general, voles of the genus *Microtus* are associated with mesic or wet habitats dominated by graminoid vegetation. Graminoid vegetation serves both as the primary cover and as the major food source for most vole species. Most voles feed primarily on the vegetative portion of grasses and sedges. They are some of the most prolific mammals and their biomass may exceed all other animals in certain grassland habitats.

In New Mexico, the meadow vole (*M. pennsylvanicus*) is typically associated with grass-sedge hydrosere communities at permanent water, primarily in the mid-elevations of the Sangre de Cristo Mountains in northern New Mexico (Findley et al. 1975). In contrast, the long-tailed vole (*M. longicaudus*) has a more broad geographic and ecologic distribution in New Mexico. This species occupies relatively mesic, but not necessarily wet, sites within meadows and forests in the higher mixed conifer and boreal forest zones throughout New Mexico (Findley et al. 1975). It seems to reach its greatest densities in riparian habitats although it can also be found in meadows and forest (personal observation).

In the Southwest, *M. longicaudus* and *M. pennsylvanicus* occur together only in the Sangre de Cristo Mountains (Findley et al. 1975). Here, both species may be captured in the same valleys (personal observation). A. Hope reported capturing both species in Taos Canyon on Carson National Forest. Although there are no published data on habitat associations of these two species when they occur together in New Mexico, anecdotal evidence indicates that *M. pennsylvanicus* typically occupies the wetter grass-sedge communities while *M. longicaudus* occupies more shrubby (i.e., willow) or forested areas (personal observation). A different situation was found at the Ojo Sarco meadow. Here, as typical of other sites where it is known to occur, *M. pennsylvanicus* was found in the more mesic grass-sedge-cattail community associated with the moist soils and standing water of the drainage and tank. However, *M. longicaudus* was found in the upland portion of the meadow in tall, dense grasses where the soil was not wet. This unusual finding demonstrates that *M. longicaudus* can occupy drier sites if adequate grass cover is available; shrubby and forested habitats are not required. This is important because it indicates that voles can occupy a

broader spectrum of meadow habitats providing adequate cover exists. These results are consistent with the general observations that when different species of vole occur together, competitive exclusion usually results in habitat partitioning based on moisture gradients (Getz 1985). It has been speculated that *M. longicaudus* is a poor competitor with other voles including the larger *M. pennsylvanicus* (Fitzgerald et al. 1994). The results of this study support the idea that *M. pennsylvanicus* is competitively dominant and excludes *M. longicaudus* from wetter herbaceous habitats.

Voles are active on the surface where they construct distinct runways through the base of the vegetation. Runways with greater vegetation and detritus cover provide greater protection from predators (especially avian predators). Protection from predation contributes to higher numbers of voles in dense vegetation (Getz 1985). Most species display a positive response to vegetation cover; population densities are usually higher in sites with greater cover (e.g., Birney et al. 1976, Eadie 1953). Due to the importance of vegetative cover, vole populations are highly susceptible to livestock grazing and may disappear from areas with even moderate grazing (Fagerstone and Ramey 1996). It is likely that the low stubble height at the U.S. Hill and Amole sites is the reason no voles occur in those meadows. In addition to the escape cover provided by greater stubble height, increased vegetation contributes to a greater soil moisture, which has direct and synergistic benefits for vole populations. If stubble height were decreased at the Ojo Sarco meadow to levels found at the U.S. Hill and Amole sites, it is probable that both species of voles could be extirpated. *M. longicaudus* would likely be the first species impacted since the drier upland sites would likely lose herbaceous cover first. Although many studies have demonstrated a negative impact of livestock grazing on vole populations, there is little information on specific cover requirements for various species. It has been suggested that voles may require higher threshold levels of cover to support resident populations and still higher threshold levels to support population increases (Birney et al. 1976). Data on cover requirements for each species of vole are crucial to for understanding the relationship between cover and each species and to better manage livestock.

Both *M. longicaudus* and *M. pennsylvanicus* are presumed to occupy a habitat-patch configuration consisting of small, isolated or ephemeral patches rather than large, contiguous, and relatively stable habitats (Getz 1985). Like most other voles, both of these species are prone to extreme annual variation in population densities (Taitt and Krebs 1985). At population peaks, voles may occupy marginal habitats (Getz 1985). This factor can make it difficult to describe preferred habitat and may give the impression that the species occupies a larger contiguous habitat patch than under lower densities. However, it also suggests that these species exhibit a metapopulation structure that allows them to recolonization sites where they have previously been extirpated. Recolonization would likely occur during periods of high population densities when individuals are forced to occupy marginal, intervening habitat. However, local high densities are only possible with adequate cover. Consequently, it is possible that *M. longicaudus* and *M. pennsylvanicus* could recolonize both the

U.S. Hill and Amole meadows if appropriate vegetative cover conditions were allowed to develop.

The presence of voles in a community has special significance to overall ecosystem dynamics, especially as it relates to predators of small mammals (Rose and Birney 1985). Communities containing voles tend to have a higher proportion of individuals active during the day since voles are active both day and night. Thus, voles can be important prey for diurnal predators, such as northern goshawk, as well as nocturnal predators, such as spotted owl. Communities with voles also have more predators because voles are a relatively large small mammal, are usually numerous, are available during the day and night, and are active year-round while many other species hibernate.

In addition to voles, results of this study suggest that stubble height also influence the occurrence of northern pocket gophers in montane meadows of northern New Mexico. The impact of livestock grazing on pocket gophers is variable depending on the situation. In a review of the effects of livestock grazing on pocket gophers, Fagerstone and Ramey (1996) reported substantially more studies that indicated a negative impact as compared to studies that reported no or positive impacts of grazing on gophers. They (Fagerstone and Ramey 1996) noted that gophers are associated with rangelands in good to excellent condition because these conditions promote vigorous plants with large root systems. Gopher densities also are positively correlated with plant biomass. In contrast to voles, northern pocket gophers generally require a high proportion of forbs in the diet for survival; diets composed primarily of grasses result in weight loss and death (Fagerstone and Ramey 1996). Consequently, grazing regimes that promote vigorous forb growth may be of benefit to this species. Although the biomass of gophers does not approach the levels that can be obtained by voles, gophers are important regulators of ecosystem structure and function. They are important agents in the development and maintenance of soil characteristics and nutrient cycling, they alter plant species composition, their burrows provide refuge for many other animal species, and they provide a consistent opportunistic prey base for many predators (especially weasels, badgers and owls).

Summary and Recommendations

- 1) The meadow with the greatest stubble height had the highest abundance, richness, and diversity of small mammals; the meadow with the least stubble height had the lowest while the heavily grazed meadow had the least abundance, richness, and diversity of small mammals
- 2) Tall, dense herbaceous cover on the Ojo Sarco meadow allowed for the occurrence of two species of vole; no voles occurred on the U.S. Hill or Amole meadows due to the absence of adequate herbaceous cover.
- 3) A significant decrease in herbaceous cover at the Ojo Sarco site would likely result in the extirpation of local vole populations.

- 3) Long-tailed voles are able to occur in upland meadow sites with adequate grass cover.
- 4) No pocket gophers were observed on the Amole meadow that had the lowest stubble height. Moderate stubble height did not result in the elimination of gophers.
- 5) Voles are an extremely important component of small mammal communities; they have a significant impact on ecosystem function, especially with regards to predator communities.
- 6) Studies that determine threshold levels of vegetative cover necessary for vole survival, reproduction, and population increases should be conducted. These data are critical for livestock management that allows for, or promotes, the full spectrum of natural ecosystem processes.

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